Ali Aghvami  “Rapid Fabrication of Cyclic Olefin Copolymer (COC) Microfluidics”
Cyclic olefin copolymer (COC) is increasingly popular as substrate material for microfluidics, due to its promising properties, such as high chemical resistance, low water absorption, good optical transparency in the near UV range and ease of fabrication. A wide array of fabrication methods is available to structure these materials, however there is a demand for production procedures which are more appropriate for lab applications and fabrication of disposable chips. We introduce a low-cost, rapid fabrication method for COC microfluidic chips that can be commercialized for mass production.

Cesar Agon  “Quantum Corrections to Holographic Mutual Information”
In this talk I will give a oversimplified picture of the AdS/CFT correspondence to illustrate the dual to the entanglement entropy, encoded both in the so called Ryu-Takayanagi formula and in the Faulkner, Lewkowycz and Maldacena prescription. As an application of these formulas we present some results for the leading contribution to the Mutual Information for largely separated spheres both in field theory and in the context of holography.

Mathew Chamberlain  “Form follows function: protein competition affects gene expression”
Messenger RNA is produced by RNA polymerase (RNAP) in a process called transcription. In all forms of life, RNAP is highly regulated by RNAP-associated proteins called transcription factors. In *E. coli*, it remains unclear to what extent two of these proteins can bind to RNAP during transcript elongation simultaneously. Our approach directly observes single molecules of these two proteins binding to RNAP during active transcript elongation using multi-wavelength fluorescence Co-localization Single-Molecule Spectroscopy (CoSMoS). The results reveal direct competition between the proteins. Lastly, we show that this competition directly affects gene expression by testing the competition hypothesis *in vitro* and *in vivo*.

Danny Goldstein  “A Kinetic Model of Active Extensile Bundles”
Recent experiments in active filament networks reveal interesting rheological properties (Dan Chen: APS March Meeting 2015 D49.00001). This system consumes ATP to produce an extensile motion in bundles of microtubules. This extension then leads to self-generated stresses and spontaneous flows. We propose a minimal model where the activity is modeled by self-extending bundles that are part of a cross linked network. This network can reorganize itself through buckling of extending filaments and merging events that alter the topology of the network. We numerically simulate this minimal kinetic model and examine the emergent rheological properties and determine how stresses are generated by the extensile activity. We will present results that focus on the effects of confinement and network connectivity of the bundles on stress fluctuations and response of an active gel.
David Harbage  “Regulating the size of self-assembling filamentous structures by a finite pool of subunits”
Self-assembling filamentous structures made of protein subunits are ubiquitous in cell biology. These structures are often highly dynamic, with subunits in a continuous state of flux, binding to and falling off of filaments. In spite of this constant turnover of their molecular parts, many cellular structures seem to maintain a well-defined size over time, which is often required for their proper functioning. One widely discussed mechanism of size regulation involves the cell maintaining a finite pool of protein subunits available for assembly. This finite pool mechanism can control the length of a single filament by having assembly proceed until the pool of free subunits is depleted to the point when assembly and disassembly are balanced. Still, this leaves open the question whether the same mechanism can provide size control for multiple filamentous structures that are assembled from a common pool of protein subunits, as is often the case in cells. We address this question and find that this model is sufficient to regulate the size of a multi-filament structure.

Kevin Li  “Information Transfer in Cells”
The transfer of information in cells is necessary for processes such as control of gene expression, chromosome organization and DNA repair. I will outline various ways in which information can be relayed within the cell and how these mechanisms play a vital role in the DNA damage response. When cells incur a double strand break to their DNA, histones around the lesion are phosphorylated over large distances. Using the mating type switching system in budding yeast, we show that phosphorylation spreading is accomplished by two different kinases. Simple mathematical models suggest that these kinases operate using two different methods of information transfer even though both kinases chemically modify the same targets.

Carl Merrigan  “Force Network Response to Vibrations for Grains Jammed in a 2D Hopper”
Grains falling through a narrow bottleneck may suddenly jam through the formation of an arch of mutually stabilizing grains. Given a fixed outlet width, there is a well-defined mean time needed for an arch to form. The opposite process, breaking the arch again through external vibrations, appears more complex. Instead of a fixed mean time, unjamming may occur immediately or it may take anywhere from tens to many hundreds of vibration periods. Using molecular dynamics simulations in LAMMPS, we are seeking to identify and model the kinds of changes that are responsible for destabilizing the initial jammed states. Detailed measurements of the changes to the initial configuration of the force network, point to general features of the response of jammed states to external vibrations. After an initial, transient disruption and rearrangement, the force network configuration settles into a new state that is approximately stable with respect to the vibrations. I will argue that the unjamming process depends on how well "matched" or "tuned" this resulting force configuration is to the ongoing presence of the vibrations. Stable jammed states should be those that self-organize in such a way that they can efficiently absorb and transmit stresses from the vibrations.
Jishnu Nampoothiri  “Gap statistics of avalanches in disordered spin models and its connection to plasticity in amorphous solids”

The mechanical response of an amorphous solid to an applied shear stress is characterized by sharp fluctuations in the shear stress of the material, which are called ‘avalanches’. Recent studies have revealed that a major distinction between the state of the amorphous solid prior to yielding and the steady state after yielding is in the exponent $\theta$ which characterizes the statistics of gaps $(\Delta \gamma)$ between successive avalanche events. The distribution of gaps behaves as $P(\Delta \gamma) \sim (\Delta \gamma)^\theta$ with a non-zero $\theta$ exponent in the isotropic solid state prior to yielding (at $\gamma = 0$) and $\theta = 1$ in the steady state after yielding. Disordered spin models have been very successful in the past at capturing phenomena which display ‘avalanche’ behavior and in this talk, we are going to examine the gap statistics of avalanches in a few disordered spin models and see if they exhibit a non-zero $\theta$ exponent.

Elias Putzig  “Continuum Theory of an Overdamped Active Nematic”

Active nematics are systems of rodlike particles which move or exert forces in an apolar manner. These systems exhibit novel behaviors, such as phase separation, spontaneous formation and self-propulsion of defects, and long-range ordering of transient defects. In this talk I will present a continuum theory which includes the forces exerted by the particles in addition to equilibrium dynamics of a nematic liquid crystal. This theory captures the behaviors of active nematics, which differ strikingly from what is seen in equilibrium systems, and provides some predictions concerning what controls them.

Elan Shatoff  “A Statistical Mechanics Model for Discontinuous Shear Thickening in Suspensions”

In this paper we present a model for analyzing discontinuous shear thickening (DST) in suspensions. We perform analysis on force tiles obtained from 2D simulations of suspensions undergoing DST. Using point pattern analysis techniques, including spatial correlations and structure factors, we investigate the patterns of vertices from the force tilings. We attempt to characterize a phase transition from these patterns in force space.

Mahsa Siavashpouri  “Helices of Helices”

Twisted ribbons are characteristic structural motifs that are prevalent in nature. However correlation between the macroscopic properties of the final self-assemblages and the microscopic features of the constituent molecules remain unknown. We describe a new class of supramolecular 1D assemblages with tunable mechanical properties. Using DNA origami technique, we design and structure rod-like colloidal particles that have excluded volume interactions and self-assemble into twisted ribbons in presence of attractive interactions mediated by non-absorbing polymers. By comparing behavior of DNA origami filaments and rodlike viruses we demonstrate that self-assembly into 1D twisted ribbons is universal and independent of the system materials. The control afforded by the DNA origami technology establishes a quantitative relationship between the microscopic filament structure and the macroscopic properties of the entire self-assemble. Furthermore, to understand the connection between the chirality at the molecular scale and the macroscopic chiral structures, we measured twist periodicity (pitch) of cholesteric phase associated to various DNA origami designs which can develop a new framework in understanding microscopic origin of chirality in liquid crystals.